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ABSTRACT

This study grew out of interest in how occupational role stress, moderated by personality, affects health--particularly in the area of coronary heart disease. People in organizations are now asking how occupational role demands and technological developments affect employee health. This study examined the effects of an impending shutdown of the computer center at a major university on the user's anxiety and pulse rate levels. The effects of stress on strain were hypothesized to be accentuated for the hard-driving, Type A, "coronary" personality. Examination of the mean levels of strain during the impending shutdown showed that the levels of anxiety-tension and pulse rate were significantly higher during the shutdown period. The differences in stress and strain supported the contention that the period of the impending shutdown was a trying one, and that it did have an effect on the well-being of the computer systems' users. The report summarizes analyses of the actual relationships between the changes in perceived stresses and changes in affective and physiological state. (Author/PC)

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Technological Dependency, Role Stress, and Strain[1]

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Technological Dependency, Role Stress, and Strain

This study grows out of our continuing interest in how occupational role stress, moderated by personality, affects health particularly in the area of coronary heart disease (e.g., French and Caplan, 1973; Sales, 1969, 1970). Research, an occupation close to all of us, is normally relatively free of stress. In this inquiry, however, we examine one of research's transient stresses in terms of its relationship to psychological and physiological strain.

The stress literature and data on costs have probably led people in organizations to become increasingly concerned about protecting their valuable human resources from illness and premature death. In 1963 a malady related to role stress, coronary heart disease, caused lost work time and health costs estimated at four percent of the GNP (President's Commission on Heart Disease, Cancer and Stroke, 1964). People in organizations are now asking how occupational role demands and technological developments affect such employee health.

One such technological development is the computer. Computers entered organizations in the 1950's. They created new roles, facilitated an information explosion, and produced an unprecedented dependency on high speed information processing (Toffler, 1970; Michael, 1968). This dependency is acutely demonstrated when users learn that a computer system is about to go "down." This study examines the effects of such an event on the mental and physical states of a system's users. The opportunity presented itself during the impending shutdown of a major university's computing center for a move to a new facility.

We have considered the computing environment as an open system (e.g.,

Katz and Kahn, 1966). Because the user is part of that system, it is likely that the state of the technological components will determine, in part, the state of the system's psychological and physiological components. In other words, if the computer is healthy, so will be the user.

This study examines the effects of the impending shutdown on the users' anxiety and pulse rate levels. The effects of stress on strain should be particularly accentuated for the hard-driving, Type A, "coronary" (Roseman, et al., 1966) personality. This latter hypothesis derives from research showing that Type A persons are more involved in their work (Rosenman, et al., 1970) and potentially more sensitive to changes in the work environment (Caplan, 1971; Sales, 1970).

METHOD

Sample. During the last three days preceding an announced shutdown of the central computing facility at a midwestern university, April 14-16, 1971, systems users were approached at the output window and asked if they would fill out, in a nearby sitting area, a ten-minute questionnaire dealing with their work. One hundred twenty-two males, mean age 23 (S.D. = 4.7), representing a 94 percent response rate, completed the questionnaire. Ninety-one percent of the sample were graduate and undergraduate students while the remainder were faculty or postgraduate fellows. In September 1971, which was chosen as a relatively low stress period by comparison, these same Ss were mailed an almost identical questionnaire. Time 1 in April marked what we term an objectively overloaded period, since it also coincided with the end of the academic term. September marked the beginning of a semester in which deadlines for most users were far away. Sixty percent (n = 73) of the original sample returned

questionnaires at t_2.

Measures. Three-item questionnaire measures of subjective quantitative work load and role ambiguity were administered. The measures, previously used in longer form in other R & D settings (Caplan, 1971), had estimated reliabilities (r_{kk}) ranging from .64 to .82 at times one and two. The following are examples of items measuring work load and role ambiguity respectively: "The amount of work you have to do"; and "The extent to which you know what you are supposed to do." The items were rated from "very little" to "very great" on a five-point scale.

Type A personality was measured by a subset of four items (r_{kk} = .73) described by Vickers (1973). Validation information is described by Caplan (1971). The cross-time reliability of this measure is about .69. Items such as "In comparison to most people I know, I'm very involved in my work," were rated on a seven-point scale from "very true of me" to "not at all true of me."

Psychological strain was measured by a five item index of anxiety-tension (r_{kk} = .83) developed by Cobb (1970). A thirty second pulse rate was taken at t_1 following the respondent's completion of the questionnaire. At t_2 respondents took their own pulse rates at the start and end of the questionnaire according to pretested instructions. Average number of cigarettes smoked per day was obtained from the questionnaires. These latter data were used to correct, through regression techniques, the pulse rate measures for the influence of smoking. Small sample sizes (only 13 percent of the t_2 Ss smoked) made the smoking data insufficient for other uses in analyses.

The analyses examine the relationship between changes in stress and changes in strain from t_1 to t_2. Each person is used as his own control. To treat regression toward the mean in the change scores, ad-

justments have been made for the Law of Initial Values (Wilder, 1957), using linear regression techniques. An inspection of the scatter plots of t_1 scores against their respective change scores shows that this procedure was justified statistically.

RESULTS

An examination of the mean levels of strain during the impending shutdown and at time two shows that the levels of anxiety-tension and pulse rate were significantly higher during the shutdown period (p's $< .001$ and $< .005$ respectively). Pulse rate dropped from 73.9 to 69.7 beats per minute from t_1 to t_2. Subjective quantitative work load was also higher at time one, but the difference across time only approached significance ($p < .10$). Role ambiguity remained unchanged perhaps reflecting high ambiguity at both times one and two. Time two marked the start of a new academic year which should be accompanied by various uncertainties. Mean Type A scores remained unchanged as is expected of a trait rather than state measure. These findings are presented in Table 1.

INSERT TABLE 1 ABOUT HERE

These differences in stress and particularly in strain support our contention that the period of the impending shutdown was a trying one, and that it did have an effect on the well-being of the computer systems' users. We now turn to analyses of the actual relationships between the changes in perceived stresses and changes in affective and physiological state from times one to two. Analyses produced the following results which are summarized in Figure 1.

INSERT FIGURE 1 ABOUT HERE

First, changes in level of subjective work load from time one to

two were positively correlated with changes in anxiety-tension ($r = .38$, $p < .001$). Changes in anxiety-tension were in turn positively associated with changes in heart rate ($r = .33$, $p < .005$). Changes in subjective work load were also associated with changes in heart rate, but the relationship was nonsignificant ($p < .10$) and dropped from .16 to .05 when anxiety-tension was partialled out. Consequently, if perceived work load had any effect on heart rate, it was via its impact on the person's state of anxiety. Changes in role ambiguity also proved to be positively correlated with changes in anxiety-tension ($r = .25$, $p < .05$), but were unrelated to changes in heart rate ($r = -.03$).

To see whether the effect of stress on strain was greatest for Type A persons, the sample was split at the median of the personality score distribution. The correlation between subjective work load and anxiety-tension is .54 for the As and only .27 for the Bs, although the significance of the difference is low ($p < .10$). However, the slope of the regression of work load on anxiety-tension is significantly higher for the As than for the Bs (betas = .61 and .17 respectively, $p_{difference} < .05$). Similarly, there was a nonsignificant tendency for the correlation between anxiety-tension and heart rate to be higher for the As than for the Bs, although there was no difference in the regression slopes of the two personality types.

Since anxiety-tension has multiple predictors in this study, multiple regression analyses were performed to find each predictor's relative importance. The interaction of subjective work load and Type A (entered into the regression as the product of work load and Type A) turned out to be far more important than the main effect of work load alone (betas of .45 versus .00). This supports the contention that technologically related stress should have its greatest effect on the

most involved, hard-driving persons--the Type As. Role ambiguity was also a significant predictor (beta = .29). Together these effects account for 27 percent of the variance ($R = .52$, $p < .001$) in anxiety. The details of this regression are presented in Table 2.

INSERT TABLE 2 ABOUT HERE

DISCUSSION

Dependency on technology has been a major theme among middle twentieth century thinkers (e.g., Michael, 1968). Continued research on socio-technical relationships could do much to provide us with some useful social indicators of such dependency. Willingness to search for individual differences in ability to cope with system "crashes" may allow us to be more efficient and more humanitarian in carrying out programs of preventive organizational psychology. In the current study we confirmed that the Type Bs handle stress best. Can we discover other differences between successful and unsuccessful copers that account for such findings, and can we devise schemes for training people in some of these coping techniques? These are the questions which organizational psychologists are and will continue to be asked as our awareness of the links between humans amd their technological systems grows.

The phenomena examined here do not represent an isolated and rare organizational occurrence. Data from NASA (Villafana, 1971) suggest that highly frequent rocket launches in that organization were almost as likely as an announced reduction in work force to adversely affect the health of administrators as well as blue collar technicians. Among the effects observed were increases in mean blood pressure and cardiovascular disease, respiratory and muscular-skeletal problems, and anxiety depression. In still other sites we have also heard anecdotal reports of coronary heart

disease epidemics in certain white collar units or in continuous flow monitoring rooms. Perhaps Antoine de Saint Exupéry (1939) has summed up best the dilemma for all of us in these matters; he observed that we design our organizations after models of ourselves, but we are often unable to predict what types of humans those organizations will in turn produce. Our computers and other systems are clearly products of our ingenuity. Hopefully such ingenuity in socio-technical research will help us cope with some of the unintended consequences of our inventions.

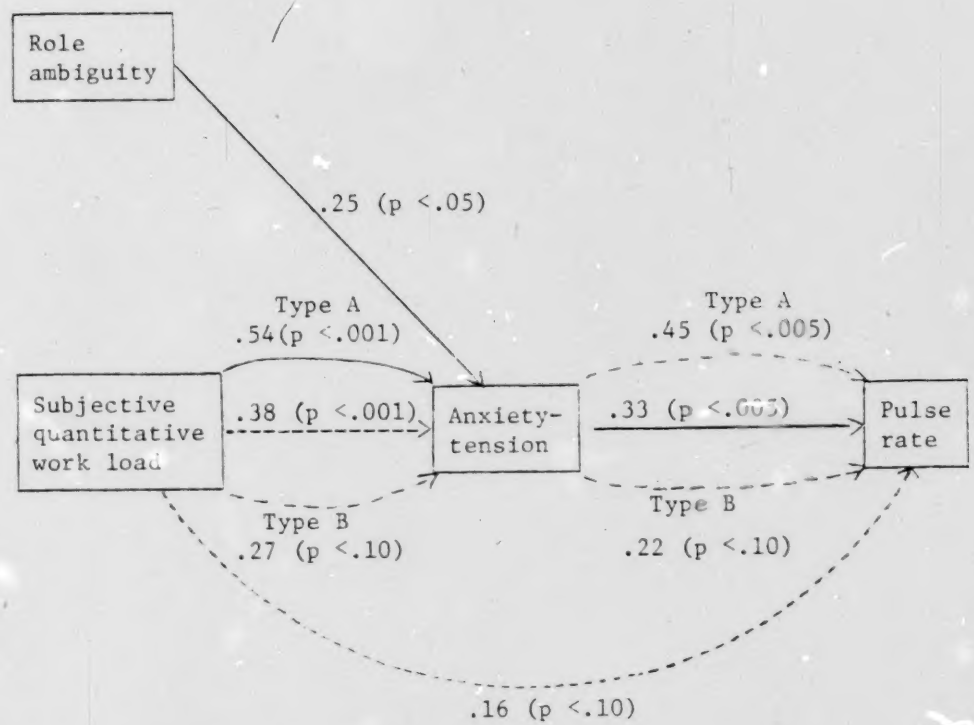

Figure 1. Theoretical interpretations of the relationships between perceived work load, anxiety, Type A/B personality, and pulse rate. Solid arrows indicate the most probable pathways between the stresses and strains based on multiple regression analyses and tests of significance in the case of interactions with personality. Dotted arrows represent less probable pathways. First-order correlations are presented.

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Table 1

Means and Standard Deviations of Stress, Strain and Personality at Times One and Two[1]

Measure	Time 1 $\bar{X}$	Time 1 S.D.	Time 2 $\bar{X}$	Time 2 S.D.	$T_1 > T_2$, $p <$
Subjective Stress					
Quantitative work load	3.55	.79	3.39	.66	.10
Role Ambiguity	2.20	.66	2.26	.54	n.s.
Strains					
Anxiety-tension	2.29	.75	1.83	.58	.001
Heart Rate	73.90	13.26	69.74	11.59	.005
Personality					
Type A	4.71	1.21	4.68	1.06	n.s.

[1]Data uses each person as own control. N = 73.

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Table 2

Multiple Regression of Predictors of Anxiety-Tension[1]

Predictor	beta	partial
Δ Work Load	.00	.00
Δ Work Load x Type A/B	.45	.18
Δ Role Ambiguity	.29	.31

[1] $R = .52$, $p < .001$. The multiple regression of all predictors in Figure 1 on pulse rate is not higher than the first-order correlation between anxiety-tension and pulse rate.

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